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REMOTE AIR BAG DEPLOYMENT REPORT

CASE NUMBER - IN00-007
LOCATION - OKLAHOMA
VEHICLE - 1997 HYUNDAI ACCENT
CRASH DATE - February 1998

Submitted:

July 31, 2000

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August 25, 2000



Contract Number: DTNH22-94-D-17058

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

Technical Report Documentation Page

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15. <i>Supplementary Notes</i> Remote air bag deployment report involving a 1997 Hyundai Accent, with manual safety belts and dual front air bags, a 1995 Ford Contour, and a 1989 Ford Ranger pickup truck			
16. <i>Abstract</i> This report covers a remote investigation of an air bag deployment crash that involved a 1997 Hyundai Accent (case vehicle, vehicle #2), a 1995 Ford Contour (vehicle #1), and a 1989 Ford Ranger pickup truck (vehicle #3). This crash is of special interest because the case had deployed front air bags and a child fatality at the front right passenger position. The child (4-year-old Asian female) was unrestrained and sustained fatal cervical spine injuries as a result of contacting her deploying air bag. The case vehicle and vehicle #3 were both traveling west in the inside westbound lane of a four-lane, undivided city street, approaching a three-leg "T" intersection and intending to continue westbound. Vehicle #1 was traveling south in the southbound lane of a two-lane, undivided city street, approaching the same intersection. Vehicle #1 was attempting to make a left-hand turn across the two westbound travel lanes to travel east. The case vehicle driver braked and steered left trying to avoid vehicle #1. The crash occurred at the middle of the intersection. This crash sequence included three impacts. The first impact occurred when the case vehicle's front contacted the left side of vehicle #1, causing the case vehicle's driver and front right passenger air bags to deploy. Post-impact, the case vehicle rotated slightly counterclockwise and came to rest diagonally astride the center line, heading southwest. After the initial impact with the case vehicle, vehicle #1 rotated over 90 degrees counterclockwise and struck the south curb line with its right rear tire and wheel, displacing the wheel. At final rest, vehicle #1 was in the outside eastbound lane heading northeast. The third impact consisted of vehicle #3's front left bumper corner impacting the back left bumper corner of the case vehicle. There is no knowledge of pre-crash posture or seat adjustments for the case vehicle's child fatality. She sustained a cervical spine fracture (confirmed by x-ray). No autopsy was performed. The case vehicle's restrained driver (29-year-old female) sustained police-reported "possible" injuries. Both case vehicle occupants were transported from the scene by ambulance to a hospital.			
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Additional photographs are available in SCI EDCS case IN00-007

This case was brought to the NHTSA's attention by a review of the 1998 Fatality Analysis Reporting System (FARS). The crash involved a 1997 Hyundai Accent (case vehicle, vehicle #2), a 1995 Ford Contour (vehicle #1), and a 1989 Ford Ranger pickup truck (vehicle #3). The crash occurred in February 1998, at 11:36 a.m., in Oklahoma, and was investigated by the applicable metropolitan police department. This case is of special interest because the case vehicle had deployed front air bags and a child fatality at the front right passenger position. The case vehicle's front right passenger (4-year-old Asian female) was unrestrained and sustained a fracture of the cervical spine (confirmed by x-ray). No autopsy was performed. The Police Crash Report was received in April 2000, and the police photographs and medical examiner's report in May. This report is based on the Police Crash Report, the Report of Investigation by Medical Examiner, police photographs, occupant kinematic principles, and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The case vehicle and vehicle #3 were both traveling west in the inside westbound lane of a four-lane, undivided city street, approaching a three-leg "T" intersection. Presumably, they were intending to continue their westbound travel paths (**Figure 1**). Vehicle #1 was traveling south in the southbound lane of a two-lane, undivided, intersecting city street, approaching the same three-leg "T" intersection and being controlled by a stop sign. Vehicle #1 was attempting to make a left-hand turn across the two westbound travel lanes and begin an eastbound travel path (**Figure 2**). The investigating officer indicated in the narrative section of the Police Crash Report that there was a non-contact vehicle traveling west in the outside westbound lane that may have been a partial view obstruction for the three involved vehicles. Additionally, witnesses stated that two other vehicles had to brake in order to avoid colliding with vehicle #1. The case vehicle's driver braked and steered to the left trying to miss vehicle #1. The crash occurred at or near the east-west center line in the middle of the intersection.

It was daylight, the weather was cloudy, and the pavement surface was dry. For the east-west roadway [case vehicle and vehicle #3], the street surface was bituminous, straight, downgrade to the west, and a posted speed limit of 56 km.p.h. (35 m.p.h.). Pavement markings included a double solid yellow center line and single broken white lane lines

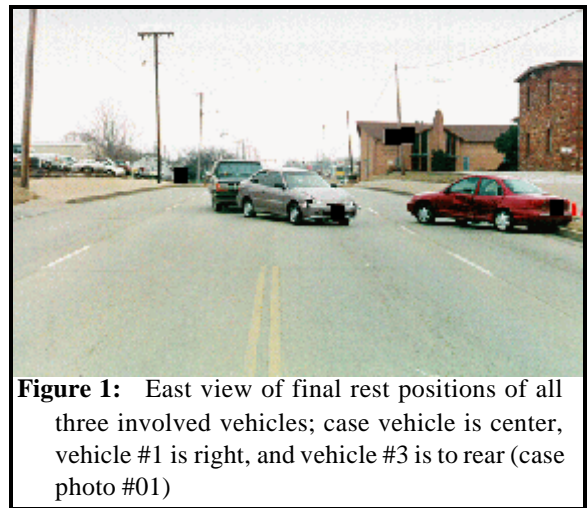


Figure 1: East view of final rest positions of all three involved vehicles; case vehicle is center, vehicle #1 is right, and vehicle #3 is to rear (case photo #01)

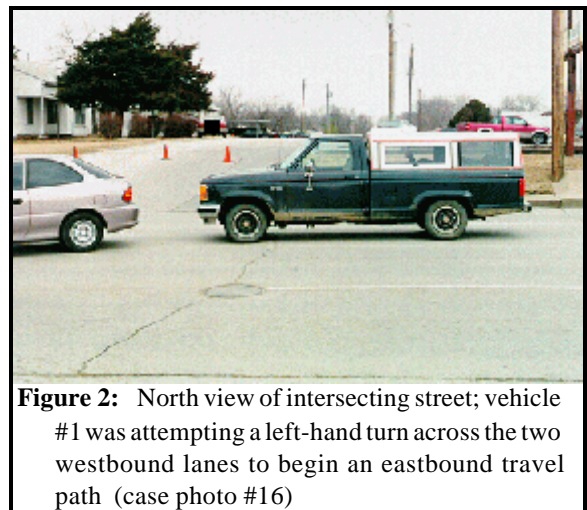


Figure 2: North view of intersecting street; vehicle #1 was attempting a left-hand turn across the two westbound lanes to begin an eastbound travel path (case photo #16)

separating the dual lanes in each direction. The outside edges of the pavement were bordered by gutters and 15 centimeter (6 inch) concrete barrier curbs. The police-estimated pre-crash travel speed for the case vehicle was 56 km.p.h. (35 m.p.h.) and its impact speed with vehicle #1 was estimated as 24 km.p.h. (15 m.p.h.). For vehicle #3, the police-estimated pre-crash travel speed was 56 km.p.h. (35 m.p.h.) and its impact speed with the case vehicle was estimated as 16 km.p.h. (10 m.p.h.). For the north-south roadway (vehicle #1), the street surface was bituminous, straight, downgrade to the south near the intersection, and a posted speed limit of 56 km.p.h. (35 m.p.h.). No pavement markings were visible in available photographs and the outside edges of the pavement were bordered by curbs of inconsequential height. The police-estimated pre-crash travel speed for vehicle #1 was 0 km.p.h. (0 m.p.h.) and the impact speed with the case vehicle was 24 km.p.h. (15 m.p.h.). The zero travel speed estimate for vehicle #1 reflects its having stopped for the stop sign on the intersection's north leg.

This crash sequence included three impacts. The first impact occurred when the case vehicle's front contacted the left side of vehicle #1, causing the case vehicle driver and front right passenger supplemental restraints (air bags) to deploy. Post-impact, the case vehicle rotated slightly counterclockwise and came to rest diagonally astride the center line, with its front in the inside eastbound lane, its rear in the inside westbound lane, and heading southwest. The sequence of the second and third impacts is not known. After the initial impact with the case vehicle, vehicle #1 rotated approximately 90 degrees counterclockwise and struck the south curb with its right rear tire and wheel with sufficient force to displace the wheel (bottom in, top out). At final rest, vehicle #1 was in the outside eastbound lane facing northeast. The third impact consisted of vehicle #3's front left lightly impacting the back left of the case vehicle. The crash severity for the case vehicle was on the low side of moderate [24-40 km.p.h. (15 to 25 m.p.h.)].

CASE VEHICLE

The case vehicle was a front wheel drive, 1997 Hyundai Accent L, five passenger, three-door hatchback (VIN: KMHVD14N3VU-----) equipped with a 1.5 liter, I-4 gasoline engine and an automatic transmission with a console mounted selector lever. Four-wheel anti-lock brakes were an option for this vehicle, but it is not known if the case vehicle was so equipped. The case vehicle's wheelbase was 240 centimeters (94.5 inches). An odometer reading was not reported. The case vehicle was towed from the scene due to disabling damage.

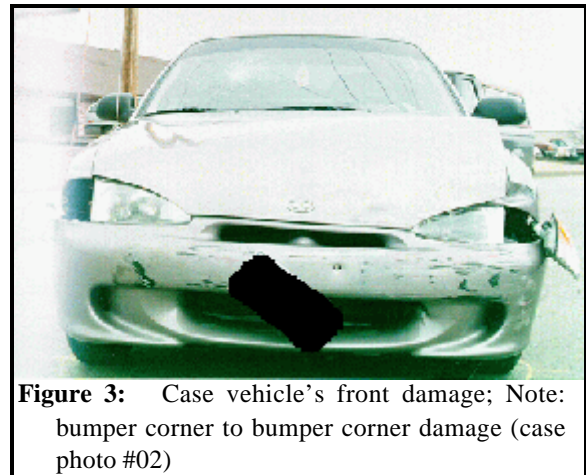


Figure 3: Case vehicle's front damage; Note: bumper corner to bumper corner damage (case photo #02)

From contact with vehicle #1, the case vehicle sustained direct contact damage to its front, virtually bumper corner to bumper corner (**Figure 3**). The residual damage was largely scraping with minimal rearward displacement to the front bumper fascia. The front edge of the hood was pushed rearward with its left side seam slightly tented. Induced damage included both turn signal assemblies being "popped out" of their respective locations and dangling by their wiring. Both the right front and left front fenders were slightly buckled. Also, photographs of the case

vehicle's left front show an undercarriage component touching the pavement, possibly the forward portion of the left front wheel well's splash guard. No intrusion to the case vehicle was noted.

A CDC from police photographs was estimated for the case vehicle's most severe impact: **01-FDEW-1 (030)**. The WinSMASH reconstruction program, with CDC-only estimated crush profile, provided a borderline reconstruction, but the results appear reasonable. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 23.5 km.p.h. (14.6 m.p.h.), -20.4 km.p.h. (-12.7 m.p.h.), and -11.8 km.p.h. (-7.3 m.p.h.).



Figure 4: Case vehicle's back left bumper corner damage from rear-end impact by vehicle #3 (case photo #06)

The second impact to the case vehicle occurred when its rear left bumper corner was contacted by vehicle #3's front left bumper corner (**Figure 4**). A WinSMASH reconstruction run was not performed but a CDC for the case vehicle was estimated as: **07-BLLN-1 (220)**.

AUTOMATIC RESTRAINT SYSTEM

Police photographs show the case vehicle driver's air bag module was located in the steering wheel hub and the front right passenger's air bag module was located in a top-mount position on the right side of the instrument panel. The photographs verify that both air bags deployed (**Figure 5**). No photographs were available to indicate what type of cover flap configuration existed for the driver's module, but the right front passenger's module was equipped with a single, "J"-shaped (with the curved portion facing the vehicle's rear), vinyl covered, hinged towards the windshield, cover flap. As no photograph of the driver module's cover flap is available, it is unknown if the driver contacted it. No occupant contact can be detected on the driver's air bag fabric. As well, no occupant contact was discovered on the front right passenger's air bag fabric, but there were possible scratches/cloth transfers to the bottom left corner of the passenger's cover flap and just to the left of the cover flap's tear seam on the instrument panel's surface.



Figure 5: Case vehicle's deployed front air bags (case photo #18)

The case vehicle's driver air bag shape is not known. With a three-stitch, circular center, the driver's air bag is likely tethered. There is also visible evidence that the driver's air bag had at least one vent port. The front right passenger's air bag is rectangular in shape (**Figure 6**). Although there is one line of stitching visible on the passenger air bag, it is uncertain if it is tethered. No vent ports for the passenger's air bag were detected in available photographs.

CASE VEHICLE FRONT RIGHT PASSENGER

The case vehicle's front right passenger (4-year-old female, Asian, height and weight unknown) was not wearing her available, manual, three-point, lap-and-shoulder safety belt system. Her pre-crash seat adjustments and posture are not known. There are no photographs of the front outboard safety belts.

The case vehicle's driver steered left and braked prior to the initial impact. These maneuvers would have caused the front right passenger to move slightly to the right and forward. At impact with vehicle #1, her forward momentum possibly resulted in her striking the left vertical seam of the passenger's air bag module's cover flap with an unknown body part and the deploying air bag propelled her into the windshield, leaving hair in the cracks (**Figure 7**). The case vehicle's post-impact counterclockwise rotation would have caused a slight movement to the right. She deposited a piece of skin on the front right sunvisor (**Figure 8**) and possible scraping marks on the right front interior door panel.

The front right passenger was transported by ambulance from the scene to a medical facility. Her time of death was recorded as 24 minutes post-crash. No autopsy was performed. The only injury listed on the Report of Investigation by Medical Examiner was a "probable cause of death" given as fracture, cervical spine, which was confirmed by x-ray.

The Report of Investigation by Medical Examiner includes an annotation indicating that the fatal victim was in the back right seat position and was propelled over the front seat and into the windshield.



Figure 6: Case vehicle's front right passenger air bag; Note: arrows point to possible occupant contact areas (case photo #21)



Figure 7: Case vehicle's windshield struck by the front right passenger; Note: arrow points to hair transfer (case photo #20)

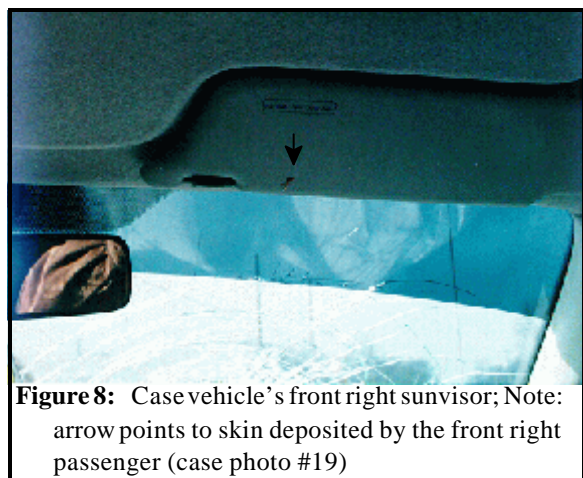


Figure 8: Case vehicle's front right sunvisor; Note: arrow points to skin deposited by the front right passenger (case photo #19)

The police photographs include numerous views of the back right seat position and its restraint system. The investigating police officer ultimately determined that the fatal victim was in the front right seat position, but this is not reflected in the Medical Examiner’s report. This contractor agrees that the victim was in the front right seat. In particular, neither the adjustable head restraint nor the seat back on the front right bucket seat was deformed in any manner, as would be expected if the victim had been thrown from the back seat over the front seat into the windshield.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Traumatic cervical spine injury NFS, fatal, no autopsy	615999.7 unknown	Passenger air bag	Probable	Coroner’s Report
2.	Fracture, cervical spine, NFS	650216.2 moderate	Passenger air bag	Probable	Coroner’s Report

CASE VEHICLE DRIVER

The case vehicle’s driver (29-year-old female, race/ethnicity, height, and weight unknown) was wearing her available, manual, three-point, lap-and-shoulder safety belt system. Her pre-crash seat adjustments, steering wheel position, and posture are not known. The driver steered left and braked prior to the initial impact, which would have caused her to move slightly right and forward, but her body movement would have been limited by the use of her lap-and-shoulder safety belt. At impact, her forward momentum would have been retarded by her use of the three-point belt. However, she would have loaded both the lap and the shoulder portions of the belt system. The case vehicle’s post-impact counterclockwise rotation would have caused her to move slightly to the right. No photographic evidence is available that indicates what interior vehicle components were contacted by the case vehicle’s driver (if any). She was transported by ambulance from the scene to a medical facility. Police assessed her injuries as “possible,” with trauma to the head, trunk-internal, arm, and leg. Her specific injuries and treatment status are not known.

Vehicle #1 was a front wheel drive, 1995 Ford Contour LX, five passenger, four-door sedan (VIN: 1FALP66L2SK-----) equipped with a 2.5 liter, V-6 gasoline engine and an unknown transmission type. Four-wheel anti-lock brakes were an option for this vehicle, but it is not known if vehicle #1 was so equipped. Vehicle #1's wheelbase was 271 centimeters (106.5 inches). No odometer reading was reported. It was towed from the scene due to disabling damage.



Figure 9: Vehicle #1's left side damage from contact with the case vehicle (case photo #12)

From the collision with the case vehicle, direct damage to vehicle #1 included lateral crush to the left front door panel, the left lower "B" pillar, the left rear door panel, the left rocker panel and the forward portion of the left rear wheel well (**Figure 9**). Induced damage consisted of sheet metal buckling at the rear portion of the left front fender. Intrusion, if any, would have been limited to the lower left areas of the left outboard seat positions. Based on police photographs, a CDC for vehicle #1's impact with the case vehicle was estimated as: **10-LPEW-2 (300)**. The WinSMASH reconstruction program, with CDC-only estimated crush profile, provided a borderline reconstruction, but the results appear reasonable. Vehicle #1's calculated Total, Longitudinal, and Lateral Delta Vs are: 18.3 km.p.h. (11.4 m.p.h.), -9.1 km.p.h. (-5.7 m.p.h.), and 15.8 km.p.h. (9.8 m.p.h.).

Post-impact, vehicle #1 rotated counterclockwise and its right rear tire and wheel struck the south curb. Direct damage was to the right rear tire and wheel, with it being knocked askew. The bottom of the tire and wheel was pushed inward and the top outward (**Figure 10**). There may have been some minor scraping to the underneath portion of the right rear bumper corner from contact with the top of the concrete barrier curb. An estimated CDC for the tire and wheel curb impact was: **03-RBWN-3 (090)**. This latter impact is outside the scope of the WinSMASH reconstruction program. Vehicle #1's driver (65-year-old male; race/ethnicity, height, and weight unknown) was reportedly wearing his available, manual, three-point, lap-and-shoulder, safety belt system. His pre-crash seat adjustments, steering wheel position, and posture are not known. He was transported from the scene by private vehicle to an unspecified location. Police assessed his injuries as "possible," with trauma to the trunk-internal, arm, and leg. His specific injuries and treatment status are not known.

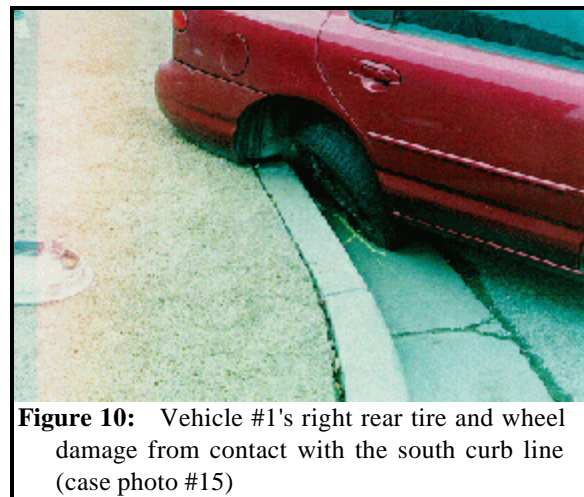


Figure 10: Vehicle #1's right rear tire and wheel damage from contact with the south curb line (case photo #15)

Vehicle #3 was a rear wheel drive, 1989 Ford Ranger pickup truck, 4x2, regular cab, camper top (VIN: 1FPCR10A0KU-----) equipped with a 2.3 liter, I-4 gasoline engine and an unknown transmission type. It was not equipped with an anti-lock braking system. Vehicle #3's wheelbase was 274 centimeters (107.9 inches). No odometer reading was reported. Vehicle #3 was removed from the scene by the driver's husband. From the rear-end collision with the case vehicle, the police photographs do not provide any definitive evidence of direct damage to vehicle #3 (**Figure 11**). Thus, no CDC could be estimated. As well, no WinSMASH reconstruction program was attempted. Vehicle #3's driver (25-year-old female, race/ethnicity, height, and weight unknown) was reportedly wearing her available, manual, three-point, lap-and-shoulder safety belt system. Her pre-crash seat adjustments, steering wheel position, and posture are not known. She was transported by ambulance from the scene to a medical facility. Police assessed her injuries as "possible," with trauma to the head, trunk-internal, arm, and leg. Her specific injuries and treatment status are not known. Vehicle #3's front right passenger (5-year-old female, race/ethnicity, height, and weight unknown) was reportedly wearing her available, manual, three-point, lap-and-shoulder safety belt system. Her pre-crash seat adjustments and posture are not known. She was transported by ambulance from the scene to a medical facility. Police assessed her injuries as "possible," with trauma to the trunk-internal. Her specific injuries and treatment status are not known.

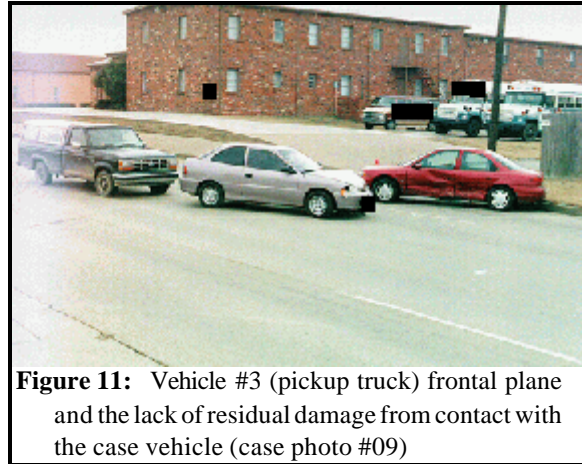


Figure 11: Vehicle #3 (pickup truck) frontal plane and the lack of residual damage from contact with the case vehicle (case photo #09)